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Research on Enterprise ordering and Transportation Model based on Fuzzy Comprehensive Evaluation and Multi-objective Optimization

Lifeng Chen, Xin Chen, Boxi Wei, Xu Zhang

School of Marine Engineering, Jimei University, Xiamen, Fujian, 361021, China

Abstract: *This paper makes reasonable assumptions about the ordering and transportation of materials in production enterprises, uses the relevant knowledge of statistics and operational research to establish a model, and reasonably formulates the optimization strategy of raw material ordering and transportation. Firstly, the influence model of fuzzy evaluation of enterprise production is established. This paper makes a comprehensive evaluation of the six factors affecting the production of the enterprise, evaluates the influence of the importance of the production of the enterprise, and then assigns the weight of the influencing factors, so as to establish a comprehensive evaluation model, according to which the strength of the supplier can be deduced. The supply intensity index and the types of suppliers evaluate the supply characteristics of suppliers. Finally, the weight is (0.3508, 0.3304, 0.3188). Then this paper first establishes the optimal ordering scheme model of modular multi-objective optimization, analyzes the constraints, establishes a set of linear programming equations to solve it, and adjusts it according to the actual situation. The optimal ordering scheme can be obtained.*

Keywords: *Ordering and transportation, Multi-objective optimization, Fuzzy evaluation, Evaluation*

1. Introduction

For enterprises, the establishment of optimization and prediction model to accurately specify the supplier ordering and transshipment plan to ensure the smooth progress of the enterprise production plan is an important problem in the actual production process.

2. Summary and General Idea of Fuzzy Evaluation Model

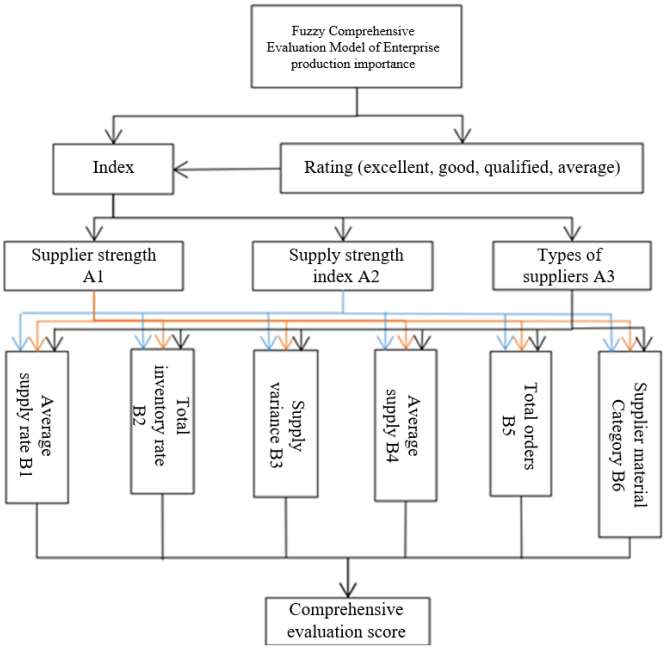

Figure 1: Structure diagram of fuzzy hierarchy evaluation model of enterprise production importance

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According to the membership degree theory of fuzzy mathematics, qualitative evaluation is transformed into quantitative evaluation, that is, fuzzy mathematics is used to make an overall evaluation of things or objects restricted by many factors [1] [2].

Considering that the impact on the importance of enterprise production is a vague concept, coupled with a variety of factors affecting enterprise production, the impact of these factors on enterprise production is different [3-5], and some qualitative and some are non-qualitative, and have different practical meanings. Therefore, the fuzzy comprehensive evaluation method can be used to evaluate the impact of six factors on enterprise production.

3. Construction of fuzzy evaluation model

3.1 Modeling steps

Deterministic factor set:

$$\mathrm{U}=\{u1,u2,\cdots\cdots,u\mathrm{n}\} \tag{1}$$

Determinate judgment set (evaluation set or decision set):

$$V=\{v1,\quad v2,\quad \cdots\cdots,\quad vm\} \tag{2}$$

Single factor evaluation: establish single factor fuzzy evaluation matrix

$$R=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \tag{3}$$

3.2 Analysis of influencing factors

The average supply rate is determined by the ratio of supply quantity to order quantity, which can well reflect whether the supplier can deliver goods in time [6-8].

The total inventory rate is determined by the number of times the average supply rate is greater than 1 divided by the total number of times, reflecting the supply strength of the supplier.

The variance of supply quantity is determined by the difference between the average of each supply quantity and the total quantity, which reflects the supply stability and operation capacity of an enterprise.

Different suppliers have different kinds of materials. There are three types of materials: A, B and C. The consumption of materials per cubic meter of products and the purchase price of materials are also different.

From the perspective of enterprise production, each factor is evaluated and the single factor evaluation matrix R of enterprise production factors is obtained. Determination of full inventory rate evaluation: Total inventory ratio is an important component of enterprise production [9-10]. According to relevant data, the membership degree of total inventory ratio for enterprise production evaluation is 0.4, 0.3, 0.2 and 0.1, respectively. Similarly, according to the relevant information and combined with their characteristics, we can get the factors influencing the level of average supply rate and so on.

3.3 Model solving process

Table 1: Membership degree result

Evaluation factors	Excellent	Good	Qualified	General
Average supply rate	0.35	0.4	0.15	0.1
Total inventory rate	0.4	0.3	0.2	0.1
Average supply volume	0.35	0.3	0.15	0.2
Supply variance	0.5	0.28	0.15	0.07
Total number of orders	0.3	0.36	0.19	0.15
Material type	0.42	0.35	0.15	0.08

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Therefore, from the perspective of enterprise production, we can analyze and get the evaluation matrix

$$\boldsymbol{R}=\begin{bmatrix} 0.35 & 0.4 & 0.35 & 0.5 & 0.3 & 0.42 \\ 0.4 & 0.3 & 0.3 & 0.28 & 0.36 & 0.35 \\ 0.15 & 0.2 & 0.15 & 0.15 & 0.19 & 0.15 \\ 0.1 & 0.1 & 0.2 & 0.07 & 0.15 & 0.08 \end{bmatrix} \tag{4}$$

The single factor evaluation matrix R of six factors of enterprise production can reflect the evaluation of each factor itself, but it can not determine the importance of factors' influence. In order to measure the influence degree of average supply rate, total inventory rate and other influencing factors on enterprise production, the three factors should be quantified and weighted based on enterprise production

$$A=\left(0.2,0.25,0.1,0.2,0.1,0.15\right) \tag{5}$$

$$P=AR=\left(0.4,0.25,0.2,0.15\right)\begin{bmatrix} 0.35 & 0.4 & 0.35 & 0.5 & 0.3 & 0.42 \\ 0.4 & 0.3 & 0.3 & 0.28 & 0.36 & 0.35 \\ 0.15 & 0.2 & 0.15 & 0.15 & 0.19 & 0.15 \\ 0.1 & 0.1 & 0.2 & 0.07 & 0.15 & 0.08 \end{bmatrix} \tag{6}$$

Accordingly, from the perspective of enterprise production, the impact of the six factors on enterprise production is of some importance. In the comprehensive evaluation results, the descending order of the impact importance is as follows: Total inventory rate, average supply rate, variance of supply rate, material type, mean supply quantity and total order quantity weight are 0.3105, 0.2975, 0.29, 0.285, 0.275, 0.2705.

By full inventory rate, average availability rate, delivery rate variance, material type, average distribution, the total weight of the side impact on the enterprise production, and the whole inventory rate, the average delivery rate, delivery rate variance, the weight of material influence on the tides and seasons, can introduce supplier power, supply intensity, kinds of supplier change the enterprise to the importance of the production for decreasing order as follows: Supplier strength, supply strength index and supplier type weight are 0.3508, 0.3304 and 0.3188 respectively.

4. Optimal ordering scheme model based on multi-objective optimization

4.1 Model building

Goal 1: Order raw materials at the lowest price

Therefore, under the premise of choosing merchants with high reputation, that is, when the deviation between supply and order quantity is maintained in a small interval, enterprises need to choose as many C-type raw materials as possible to minimize the ordering cost.

$$\mathrm{Z}=\min\left\{1.2\mathrm{A}+1.1\mathrm{B}+\mathrm{C}\right\} \tag{7}$$

Goal 2: The total order quantity meets the production capacity demand of the enterprise

In order to ensure the normal production, the enterprise should try to maintain at least two weeks of production needs of raw material inventory.Combined with the loss in the process of transportation, enterprises should properly order more raw materials under the premise of meeting the theoretical capacity demand.

$$0.6\mathrm{A}+0.66\mathrm{B}+0.72\mathrm{C}\geq 2.82*104^{*}2 \tag{8}$$

In solving the comprehensive objective, this paper first converts the multi-objective programming into a single objective programming, and uses range method to unify the dimensions of the two objectives and three raw materials into a quantity whose value range is [0,1].

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$$\min 0.65A' + 0.8B' + 0.25C'$$
$$Z\min = 1.12W \tag{9}$$
$$2.82 * 104^{*}2 \le 0.6A + 0.66B + 0.72C \le 3.38^{*}104^{*}2$$

$$\begin{cases} 0 \le A \le 9.4 * 10^4 \\ 0 \le B \le 8.55 * 10^4 \\ 0 \le C \le 7.83 * 10^4 \end{cases} \tag{10}$$

4.2 Model solving

In order to solve the above programming model, Monte Carlo algorithm is used to search the optimal solution. Because Monte Carlo simulation needs a large number of random numbers, in order to reduce the amount of computation, the range of generating random numbers is first preliminarily estimated, and then the number of random numbers is determined. At the same time, this problem is a planning problem with constraints, so judgment should be made every time a new solution is substituted. If the conditions are met, it will be simulated; otherwise, the next set of data will be substituted for judgment

In this paper, according to the 50 highest-scoring suppliers and related data, the optimal ordering scheme is solved by using MATLAB software. After running the program for several times, the optimal solution of the ordering scheme is obtained by comparative analysis, and then the data are adjusted according to the actual reasons. The results are shown in the following table:

Table 2: Results after data adjustment

Material A/m ^{3}	Material B/m ^{3}	Material C/m ^{3}	Total/m ^{3}	Theoretical production capacity /m ^{3}	Ratio of production capacity exceeding expectations
$1.43*10^4$	$1.58*10^4$	$1.86*10^4$	$4.87*10^4$	$3.24*10^4$	14.8%

5. Conclusion

This paper makes reasonable assumptions around the problem of material ordering and transportation, uses the relevant knowledge of statistics and operational research to establish a model, and reasonably formulates the optimization strategy of raw material ordering and transportation. First of all, the six factors affecting enterprise production are comprehensively evaluated, the fuzzy comprehensive evaluation method is used to evaluate the importance of enterprise production, and then the weights of the influencing factors are assigned, thus a comprehensive evaluation model is established. Then the optimal ordering scheme model of multi-objective optimization and Monte Carlo algorithm are used to obtain the optimal ordering scheme evaluation. It makes the evaluation results more objective and accurate.

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